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Methodology for Evaluating Innovative Technologies for Low-Energy Retrofitting of Public Buildings

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Abstract

There is urgency to transform Europe into a low-carbon economy to reduce the risk of climate change and achieve sustainable energy security. One of the most cost-effective measures to meet energy reduction targets, as clearly specified in the "European Economic Recovery Plan", is to address performance of existing building stock. Buildings account for about 40% of the EUenergy consumption and one third of the GHG emissions. In particular, the state of the European building stock contains a high improvement potential. REtrofitting Solutions and Services for the enhancement of Energy Efficiency in Public Edification (RESSEEPE) is an EU funded project that focuses on the refurbishment of existing public buildings in three European cities: Coventry (UK), Barcelona (SP) and Skelleftea (SW). The aim of the project is to bring together design and decision making tools and innovative building fabric manufacturers to collaborate and improve building performance through low impact retrofitting interventions to achieve energy reduction in the region of 50%. The aim of this paper is to evaluate the process of low-energy retrofit and the selection and evaluation of low-energy technologies for retrofit. Specifically the paper looks at the decision making procedure to select advanced building technologies for high energy performance retrofitting, using Coventry University estates as a case study. The paper reviews innovative technologies and using analytical methods investigates the benefits of these potential technologies as applied to existing case study buildings within Coventry University. The interconnectivity of these buildings within the urban environment within which they sit is also evaluated.

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Keywords:Low Energy Retrofitting; Building Performance Modelling; Advanced Technology; Building Envelope; Performance Monitoring;

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1. Introduction

Energy consumption for providing comfortable and usable built environment accounts for about 40% of total energy consumption and about 36% of total Greenhouse Gas (GHG) emissions in Europe (Directive 2010/31/EU) [1]. With a significant proportion of existing buildings constructed at a period when there were no effective energy efficiency components within the relevant building codes, most of this old building stock is reaching the end of its useful life. It will require significant cost and environmental impact to replace these buildings with new construction, which annually represents about 1.5% of the building stock [2]. Therefore the state of European building stock presents significant challenges as well as improvement potential. There are a number of benefits and impacts of undertaking sustainable energy renovation of buildings as summarized in [3]:

- Economic: Energy cost savings, economic stimulus, property values and impact on public finances;
- Societal benefits such as reduced fuel poverty, health and increased comfort and productivity;
- Environmental benefits: reduced air pollution, carbon savings;
- Energy Systems Benefits: Energy Security, Avoided new generation capacity, reduced peak loads;

The low energy retrofit of existing buildings requires an all-inclusive approach that should consider the building fabric and building systems and the engagement of various stakeholders to ensure user satisfaction of the retrofit solutions implemented. Gupta and Banfield [4] in the study of 63 home energy efficiency retrofit discovered a number of beneficial and detrimental consequences associated with building energy improvements, some of the negative consequences identified included '*increased likelihood of overheating following fabric improvements, potential under-performance of low-carbon systems due to lack of understanding and inadequate installation and commissioning, along with adaptive energy behaviours leading to increased energy use and a widening gap between predicted and actual savings*' [4]. Therefore low-energy retrofit requires a systematic process of pre and post intervention performance evaluation to ensure that appropriate technologies are selected to deliver the desired comfort and planned energy reduction whilst avoiding unintended negative consequences.

This paper presents the ethos of the Retrofitting Solutions and Services for the enhancement of Energy Efficiency in Public Buildings (RESEEPE) project. The project brings together design and decision making tools, innovative building fabric manufacturers and a strong demonstration programme to demonstrate improved building performance through retrofitting. The ethos of the RESSEEPE project is to technically advance, adapt, demonstrate and assess a number of innovative retrofit technologies with a 50% energy consumption reduction targeted. A systematic process of building and technology selection implemented in the project targets the best possible retrofitting mix, customized to the needs of the particular building. The process includes the extrapolation of results to buildings with similar characteristics to evaluate the benefit of district level potential for low-energy retrofit.

1.1. RESEEPEE project description and pilot case studies

RESSEEPE is an EU funded project that focuses on the refurbishment of existing public buildings in three European cities: Coventry (UK), Barcelona (SP) and Skelleftea (SW) as shown in Figure 1. RESSEEPE aims to develop and demonstrate an easily replicable methodology for designing, constructing, and managing public buildings and district renovation projects to achieve a target of 50% energy reduction. For this purpose, a demonstration and dissemination framework with innovative strategies and solutions is developed for energy renovation at building and district level, based on the following pillars: three demonstration district retrofitting projects in three different countries representative of the breadth of EU climate conditions; cost-effective solutions for holistic energy performance improvement at building and district levels; systemic selection process to achieve optimal mix of intervention measures; development of a strategy for large scale market deployment throughout Europe); market and replication deployment plan, to ensure impact at business level; and wide impact exploitation strategy.